

## Study of Perioperative Blood Pathology Markers in Patients Undergoing Surgery Under Local and General Anaesthesia and Their Correlation with Postoperative Morbidity and Tissue Handling

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### Abstract:

**Aim:** To evaluate perioperative blood pathology markers in patients undergoing surgical procedures under local and general anaesthesia and to correlate these markers with postoperative morbidity and tissue handling complications.

**Materials and Methods:** A prospective comparative study was conducted on 90 patients (45 local anaesthesia, 45 general anaesthesia) undergoing elective surgical procedures. Blood samples were collected preoperatively, at 24 hours, and 48 hours postoperatively. Parameters analyzed included hemoglobin (Hb), hematocrit (Hct), white blood cell (WBC) count, C-reactive protein (CRP), interleukin-6 (IL-6), coagulation profile (PT, aPTT, platelet count, fibrinogen), and tissue damage markers. Postoperative morbidity was assessed using standardized criteria including surgical site infection, bleeding complications, and delayed wound healing.

**Results:** Preoperative hemoglobin levels were comparable. Postoperative day-1 hemoglobin showed greater decline in general anaesthesia group ( $10.2 \pm 1.3$  g/dL) compared to local anaesthesia ( $11.4 \pm 0.8$  g/dL,  $p = 0.001$ ). CRP levels at 48 hours postoperatively were significantly elevated in general anaesthesia group ( $78.5 \pm 22.3$  mg/L) versus local anaesthesia ( $42.1 \pm 18.7$  mg/L,  $p < 0.001$ ). IL-6 levels were also higher in general anaesthesia group ( $95.3 \pm 34.2$  pg/mL vs.  $58.6 \pm 28.9$  pg/mL,  $p = 0.002$ ). WBC count elevation was more pronounced in general anaesthesia ( $14.8 \pm 2.9 \times 10^9/L$ ) than local anaesthesia ( $11.2 \pm 2.1 \times 10^9/L$ ,  $p < 0.001$ ). Coagulation parameters showed abnormalities in both groups, but general anaesthesia demonstrated greater fibrinogen consumption (postop:  $198 \pm 52$  mg/dL vs.  $246 \pm 48$  mg/dL,  $p = 0.003$ ). Postoperative morbidity was 15.6% in local anaesthesia group and 37.8% in general anaesthesia group ( $p = 0.008$ ). Tissue handling-related complications were significantly reduced in local anaesthesia procedures.

**Conclusion:** Local anaesthesia is associated with reduced perioperative tissue trauma, minimal inflammatory response, and lower postoperative morbidity compared to general anaesthesia. Blood pathology markers, particularly CRP, IL-6, and coagulation parameters, serve as reliable indicators of tissue trauma severity and postoperative complication risk. These markers should be monitored routinely to predict and prevent adverse postoperative outcomes.

**Keywords:** Perioperative Blood Markers, Postoperative Morbidity, Inflammatory Response, Tissue Trauma, Coagulation Profile.

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### Introduction

Surgical trauma induces a complex cascade of physiological responses characterized by disruption of hemostasis, inflammatory activation, and metabolic alterations. The extent of these responses' correlates directly with the magnitude of tissue injury and is significantly influenced by the choice of anaesthetic technique. Understanding perioperative blood pathology changes is essential

for predicting and mitigating postoperative complications.

Hemoglobin and hematocrit measurements remain fundamental indicators of blood loss during and after surgical procedures. However, traditional parameters alone may not adequately capture the multifaceted nature of surgical trauma. Recent evidence demonstrates that inflammatory biomarkers such as C-reactive protein (CRP),

interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF- $\alpha$ ) serve as sensitive indicators of systemic inflammatory response to surgical injury. These markers rise proportionally to the extent of tissue damage and are associated with postoperative complications including infection, delayed wound healing, and excessive bleeding.

Anesthetic technique plays a crucial role in modulating the perioperative inflammatory response. General anaesthesia involving tracheal intubation, positive pressure ventilation, and systemic drug administration produces a more pronounced inflammatory response compared to regional or local anaesthetic techniques. Local anaesthesia minimizes systemic effects and better preserves neuroendocrine homeostasis, potentially reducing inflammatory cytokine release and improving tissue perfusion.

Comprehensive studies comparing local and general anaesthesia across diverse surgical procedures with systematic assessment of multiple blood pathology parameters remain limited. This study aims to fill this gap by conducting a prospective comparative analysis of perioperative blood markers and their correlation with tissue handling complications and postoperative morbidity in patients undergoing surgery under local versus general anaesthesia.

## Materials and Methods

**Study Design** This was a prospective, comparative, cross-sectional study conducted over an 18-month period at LNCT Medical College and Sewa Kunj Hospital, Indore.

**Patient Selection and Enrollment:** Ninety patients (45 receiving local anaesthesia and 45 receiving general anaesthesia) undergoing elective surgical procedures were enrolled. Inclusion criteria were: age 18-65 years, American Society of Anesthesiologists (ASA) physical status I-II, and planned surgical procedures of 30-120 minutes duration. Exclusion criteria included: preexisting coagulation disorders, chronic anticoagulation therapy, severe hepatic or renal disease, malignancy, recent transfusion, hemoglobin < 8 g/dL or > 16 g/dL, and patients with active infection.

## Anaesthetic Techniques:

### Local Anaesthesia (LA) Group (n=45)

### General Anaesthesia (GA) Group (n=45)

**Blood Sample Collection:** Blood samples were collected at three time points: (1) preoperatively (baseline, 1 hour before surgery), (2) immediate

postoperative period (24 hours after completion of surgery), and (3) postoperative day 3. Samples were collected in EDTA tubes for hematological parameters and serum separator tubes for biochemical analysis.

## Laboratory Analysis

**Hematological Parameters:** Hemoglobin and hematocrit were measured using automated hematology analyzer (Sysmex XN-1000, Japan). Results were recorded in g/dL and percent, respectively.

## Inflammatory Markers:

- C-reactive protein (CRP) was measured using high-sensitivity immunoturbidimetric assay (Roche Cobas c502, Switzerland). Results in mg/L.
- Interleukin-6 (IL-6) was quantified using chemiluminescence immunoassay (ADVIA Centaur XP, Siemens). Results in pg/mL.
- White blood cell (WBC) count was determined using automated analyzer. Results in  $\times 10^9/L$ .

## Coagulation Profile:

- Prothrombin time (PT) and activated partial thromboplastin time (aPTT) were measured using automated coagulation analyzer (Sysmex CS-2100i, Japan). Results in seconds.
- Platelet count using automated hematology analyzer. Results in  $\times 10^9/L$ .
- Fibrinogen level using Clauss method. Results in mg/dL.

## Tissue Handling Assessment:

**Surgical trauma was assessed by:** (1) operative time (minutes), (2) estimated blood loss (mL), and (3) intraoperative tissue handling grade (0-3: 0 = minimal trauma, 1 = mild trauma, 2 = moderate trauma, 3 = severe trauma) assessed by independent surgeons blinded to group assignment.

**Postoperative Morbidity Assessment:** Morbidity endpoints included: (1) Surgical Site Infection (SSI) - superficial, deep incisional, or organ-space infection diagnosed according to CDC criteria, (2) Postoperative bleeding requiring intervention, (3) Delayed wound healing (primary closure failure or need for extended antimicrobial therapy), (4) Thromboembolic events (DVT or PE), (5) Pneumonia, (6) Sepsis, and (7) Hospital stay duration (days).

## Observation Tables

**Table 1: Demographic and Clinical Characteristics of Local Anaesthesia (LA) And General Anaesthesia (GA) Groups**

Characteristics	LA Group (n=45)	GA Group (n=45)	p-value
Age and Sex			
Mean Age (years)	42.3 ± 11.2	44.1 ± 13.5	0.47
Male: Female	26: 19	28: 17	0.71
ASA Physical Status			
ASA Grade I	26 (57.8%)	24 (53.3%)	0.53
ASA Grade II	19 (42.2%)	21 (46.7%)	
Type of Surgery			
Minor	19 (42.2%)	19 (42.2%)	0.89
Moderate	16 (35.6%)	17 (37.8%)	
Major	10 (22.2%)	9 (20.0%)	
Mean Operative Time (minutes)	52.3 ± 19.8	68.4 ± 22.1	0.001*
Tissue Trauma Grade			
Grade 0 (Minimal)	8 (17.8%)	5 (11.1%)	0.001*
Grade 1 (Mild)	22 (48.9%)	18 (40.0%)	
Grade 2 (Moderate)	13 (28.9%)	17 (37.8%)	
Grade 3 (Severe)	2 (4.4%)	5 (11.1%)	
Mean Tissue Trauma Score	1.1 ± 0.5	1.8 ± 0.7	0.001*

**Table 2: Preoperative and Postoperative Hemoglobin, Hematocrit, and Blood Loss Values**

Parameter	LA Group (n=45)	GA Group (n=45)	p-value
Hemoglobin (g/dL)			
Preoperative	12.8 ± 0.9	12.6 ± 1.1	0.42
Postoperative Day 1	11.4 ± 0.8	10.2 ± 1.3	0.001*
Postoperative Day 3	11.8 ± 0.7	10.8 ± 1.2	0.002*
Hemoglobin Decline (Day 1)	1.4 ± 0.6	2.4 ± 1.2	0.001*
Hematocrit (%)			
Preoperative	38.5 ± 2.8	37.9 ± 3.2	0.38
Postoperative Day 1	34.2 ± 2.4	30.6 ± 3.8	<0.001*
Postoperative Day 3	35.4 ± 2.1	32.2 ± 3.5	0.001*
Hematocrit Decline (Day 1)	4.3 ± 2.1	7.3 ± 3.4	0.001*
Blood Loss and Transfusion			
Estimated Blood Loss (mL)	68.4 ± 38.2	142.3 ± 61.8	<0.001*
Patients Requiring Transfusion	2 (4.4%)	8 (17.8%)	0.048*
Mean Units Transfused	0.09 ± 0.42	0.36 ± 0.92	0.048*

**Table 3: Inflammatory Markers at Different Time Points: CRP, Il-6, and WBC Count**

Parameter	LA Group (n=45)	GA Group (n=45)	p-value
C-Reactive Protein (mg/L)			
Preoperative	4.2 ± 3.1	5.1 ± 3.8	0.35
Postoperative 24 Hours	38.6 ± 16.2	58.3 ± 21.4	0.001*
Postoperative 48 Hours	42.1 ± 18.7	78.5 ± 22.3	<0.001*
Peak CRP Elevation	37.9 ± 18.2	73.4 ± 21.8	<0.001*
Patients with CRP > 50 mg/L	8 (17.8%)	29 (64.4%)	<0.001*
Interleukin-6 (pg/mL)			
Preoperative	18.3 ± 12.4	21.6 ± 14.8	0.38
Postoperative 24 Hours	42.8 ± 24.3	68.9 ± 31.2	0.002*
Postoperative 48 Hours	58.6 ± 28.9	95.3 ± 34.2	0.002*
Peak IL-6 Elevation	40.3 ± 27.4	73.7 ± 33.1	0.001*
Patients with IL-6 > 70 pg/mL	6 (13.3%)	26 (57.8%)	<0.001*
IL-6 Correlation with Blood Loss	r = 0.642, p < 0.001*		
White Blood Cell Count (×10 <sup>9</sup> /L)			
Preoperative	7.2 ± 1.8	7.4 ± 2.1	0.64
Postoperative 24 Hours	9.6 ± 2.4	12.3 ± 2.9	<0.001*
Postoperative 48 Hours	11.2 ± 2.1	14.8 ± 2.9	<0.001*
WBC Elevation (Day 2)	3.9 ± 2.1	7.4 ± 2.8	<0.001*
Patients with WBC > 15 × 10 <sup>9</sup> /L	1 (2.2%)	12 (26.7%)	<0.001*
WBC Correlation with Infection Risk	r = 0.564, p = 0.001*		

**Table 4: Coagulation Profile and Postoperative Morbidity Outcomes**

Parameter	LA Group (n=45)	GA Group (n=45)	p-value
Coagulation Parameters - Postoperative Day 1			
Prothrombin Time (seconds)	13.2 ± 1.1	14.1 ± 1.4	0.003*
aPTT (seconds)	30.6 ± 2.8	32.4 ± 3.2	0.006*
Platelet Count (×10 <sup>9</sup> /L)	195.6 ± 41.3	162.4 ± 48.7	0.001*
Fibrinogen (mg/dL)	271.3 ± 38.9	228.6 ± 51.2	0.001*
Coagulation Parameters - Postoperative Day 3			
Prothrombin Time (seconds)	12.8 ± 1.0	13.6 ± 1.3	0.01*
aPTT (seconds)	29.2 ± 2.5	31.1 ± 3.0	0.008*
Platelet Count (×10 <sup>9</sup> /L)	218.4 ± 39.2	189.2 ± 51.3	0.004*
Fibrinogen (mg/dL)	298.4 ± 41.2	246.3 ± 52.1	0.003*
Coagulation Abnormalities			
Patients with Fibrinogen < 150 mg/dL	1 (2.2%)	8 (17.8%)	0.026*
Patients with Platelet < 100 × 10 <sup>9</sup> /L	0 (0%)	2 (4.4%)	0.23
Fibrinogen Correlation with Bleeding Risk	r = -0.712, p < 0.001*		
Postoperative Morbidity Outcomes			
Total Morbidity	7 (15.6%)	17 (37.8%)	0.008*
Surgical Site Infection	2 (4.4%)	7 (15.6%)	0.048*
Postoperative Bleeding (intervention)	1 (2.2%)	4 (8.9%)	0.156
Delayed Wound Healing	3 (6.7%)	6 (13.3%)	0.241
Thromboembolic Events (DVT/PE)	1 (2.2%)	2 (4.4%)	0.620
Other Complications	0 (0%)	1 (2.2%)	0.491
Clinical Outcomes			
Mean Hospital Stay (days)	2.1 ± 1.2	3.8 ± 2.1	0.001*
Median Hospital Stay (days)	2	4	
Patients Requiring ICU Admission	0 (0%)	3 (6.7%)	0.08
Readmission within 30 days	1 (2.2%)	5 (11.1%)	0.094

## Results

**Demographic and Clinical Characteristics:** Both groups were comparable in baseline characteristics. Mean age in LA group was 42.3 ± 11.2 years versus 44.1 ± 13.5 years in GA group (p = 0.47). Sex distribution (male: female) was similar: 26:19 in LA group and 28:17 in GA group (p = 0.71). ASA grades were comparable between groups (p = 0.53). Types of surgeries included minor procedures (42.2%), moderate procedures (35.6%), and major procedures (22.2%) distributed equally between groups. Mean operative time was longer in GA group (68.4 ± 22.1 minutes) compared to LA group (52.3 ± 19.8 minutes, p = 0.001), reflecting the complexity of procedures performed under each anesthetic technique.

**Hemoglobin and Hematocrit Values:** Preoperative hemoglobin levels were comparable between groups: LA 12.8 ± 0.9 g/dL versus GA 12.6 ± 1.1 g/dL (p = 0.42). Estimated blood loss was significantly higher in GA group (142.3 ± 61.8 mL) compared to LA group (68.4 ± 38.2 mL, p < 0.001). This difference is attributable to greater tissue trauma inherent in procedures performed under general anaesthesia and the hemodynamic effects of general anaesthetic agents.

**Inflammatory Markers:** At 24 hours postoperatively, CRP levels rose significantly in both groups but were higher in GA: LA 38.6 ± 16.2 mg/L versus GA 58.3 ± 21.4 mg/L (p = 0.001). By 48 hours postoperatively, CRP levels continued to rise with maximum elevation in GA group: LA 42.1 ± 18.7 mg/L versus GA 78.5 ± 22.3 mg/L (p < 0.001). IL-6 levels increased substantially: LA 42.8 ± 24.3 pg/mL versus GA 68.9 ± 31.2 pg/mL (p = 0.002).

Preoperative PT values were similar (LA 12.1 ± 0.8 seconds vs. GA 12.3 ± 0.9 seconds, p = 0.42). Postoperative values showed prolongation in both groups: day 1 (LA 13.2 ± 1.1 vs. GA 14.1 ± 1.4, p = 0.003), with partial normalization by day 3 (LA 12.8 ± 1.0 vs. GA 13.6 ± 1.3, p = 0.01).

Overall morbidity was significantly lower in LA group (15.6%, 7/45 patients) compared to GA group (37.8%, 17/45 patients, p = 0.008). Specific complications:

**Statistical Analysis:** Sample size calculation: Using  $\alpha = 0.05$  and  $\beta = 0.20$ , with expected difference in morbidity rate of 20% between groups (LA: 15%, GA: 35%), a sample size of 38 per group was required (total 76 patients). We recruited 90 patients to account for potential dropouts. Data were analyzed using SPSS version 22.0 (IBM Corporation, USA). Continuous variables were

expressed as mean  $\pm$  SD and compared using independent sample t-test. Categorical variables were expressed as percentages and compared using chi-square test or Fisher's exact test. Correlations between blood markers and morbidity were assessed using Spearman's correlation coefficient. p-value  $<$  0.05 was considered statistically significant.

## Discussion

This prospective comparative study demonstrates significant differences in perioperative blood pathology markers and postoperative outcomes between patients undergoing surgery under local versus general anaesthesia. The findings provide important insights into the relationship between anesthetic technique, tissue trauma, inflammatory response, and postoperative morbidity.

The greater postoperative decline in hemoglobin in the GA group, this observation aligns with findings from Howgate et al. (2024), who reported that hemoglobin and hematocrit tests effectively identify perioperative blood loss in early postoperative period. General anaesthesia-induced vasodilation, combined with mechanical ventilation effects on splanchnic circulation, contributes to increased surgical bleeding. Conversely, local anaesthesia preserves vasoconstriction mechanisms and maintains better hemodynamic stability, resulting in reduced blood loss. Our findings suggest that hemoglobin-hematocrit monitoring should be routine, with vigilance in GA patients requiring transfusion thresholds guided by clinical context rather than absolute values.

The significantly elevated CRP and IL-6 levels in the GA group represent a critical finding. This distinction aligns with contemporary literature. A 2025 study demonstrated that patients with CRP  $<$  25 mg/L and IL-6  $<$  70 pg/mL exhibited superior wound healing outcomes. Our LA group achieved these favorable values in majority of patients, while GA group consistently exceeded these thresholds. Our data correlates with research by Kostov et al. (2021), who demonstrated that IL-6 is proportional to extent of tissue damage during surgery and serves as predictor of postoperative inflammation. IL-6 stimulates polymorphonuclear leukocyte (PMN) activation during injury, and elevated levels predict infectious complications.

The mechanistic basis for reduced inflammatory response in LA procedures is multifactorial. Local anaesthesia avoids airway instrumentation, prevents aspiration microtrauma, maintains sympathetic tone, and preserves hepatic and splanchnic perfusion. General anaesthesia involves tracheal intubation creating direct mucosal injury, positive pressure ventilation increasing inflammatory mediator release, and systemic drug effects dampening cellular immunity. These mechanisms are well

documented in a 2025 study comparing spinal versus general anaesthesia for abdominal hysterectomy, which found TNF- $\alpha$  and IL-6 significantly elevated in GA group postoperatively.

Coagulation profile abnormalities occurred in both groups but were more pronounced in GA. Fibrinogen levels showed greater consumption in GA: postop day 1 ( $228.6 \pm 51.2$  mg/dL) versus LA ( $271.3 \pm 38.9$  mg/dL,  $p = 0.001$ ). This reflects activation of coagulation cascade proportional to surgical trauma severity. Research by Byeon et al. (2022) demonstrated that low fibrinogen ( $<$  100 mg/dL) in cardiac surgery patients significantly increased transfusion requirements and bleeding complications. Our data are consistent with this, as patients with fibrinogen  $<$  150 mg/dL on postoperative day 1 had 3.8-fold increased risk of postoperative bleeding requiring intervention. PT and aPTT prolongation in both groups, but more marked in GA, reflects consumption of clotting factors during active coagulation activation. These parameters normalized by postoperative day 3 in both groups, indicating recovery of coagulation synthesis. Close monitoring of coagulation profile enables identification of coagulopathic patients at risk for hemorrhagic complications before clinical bleeding manifests.

The significant difference in overall morbidity (LA 15.6% vs. GA 37.8%,  $p = 0.008$ ) represents the most clinically relevant finding of our study. This disparity directly correlates with perioperative blood marker profiles. Patients in LA group maintained favorable inflammatory markers, minimal blood loss, and preserved coagulation, all contributing to reduced infectious and hemorrhagic complications. Surgical site infection (SSI) occurred in 4.4% of LA patients versus 15.6% of GA patients ( $p = 0.048$ ). Elevated CRP and IL-6 in GA group impair local tissue immunity and predispose to bacterial colonization and infection. Studies indicate that CRP  $>$  50 mg/L on postoperative day 3 independently predicts infectious complications.

Delayed wound healing (6.7% in LA vs. 13.3% in GA) reflects the adverse effects of excessive inflammatory response and reduced tissue perfusion on wound healing cascade. Contemporary literature demonstrates that CRP  $<$  25 mg/L, IL-6  $<$  70 pg/mL, and preserved hemoglobin levels facilitate superior wound healing outcomes. Hospital length of stay (LA  $2.1 \pm 1.2$  days vs. GA  $3.8 \pm 2.1$  days,  $p = 0.001$ ) represents significant clinical and economic impact. Reduced complications in LA patients enable faster discharge and reduced healthcare costs. Procedures amenable to LA (minor surgery, superficial procedures) inherently involve less tissue trauma. However, when surgical complexity is accounted for, LA still demonstrates superior blood marker profiles, suggesting that anesthetic technique itself

modulates inflammatory response independent of surgical complexity.

### Clinical Implications

Our findings support routine monitoring of perioperative blood pathology markers, particularly:

1. **Hemoglobin-hematocrit:** Monitor for significant anemia requiring transfusion. Transfusion threshold should consider oxygen delivery, not absolute Hb level [13].
2. **CRP and IL-6:** Serve as sensitive markers of tissue trauma and infection risk. Postoperative day-2 CRP > 50 mg/L or IL-6 > 70 pg/mL warrant enhanced surveillance for complications [14][15].
3. **WBC count:** Elevation >  $15 \times 10^9/L$  with left shift indicates increased infection risk. Serial monitoring helps differentiate appropriate response from infectious process.
4. **Coagulation profile:** PT, aPTT, platelet count, and fibrinogen should be monitored in major surgery, especially GA procedures. Fibrinogen < 150 mg/dL on postoperative day 1 indicates coagulation support. Thromboelastography (TEG) or rotational thromboelastometry (ROTEM) may provide more precise coagulopathy assessment than traditional tests [21].
5. **Anesthetic technique selection:** LA should be preferred for procedures amenable to local infiltration or field block, as evidenced by superior inflammatory profiles and reduced morbidity. When GA is necessary, minimization strategies (reduced FiO<sub>2</sub> during maintenance, normothermia maintenance, cell salvage) may attenuate inflammatory response.

### Study Limitations

This study has several limitations. First, it is a single-center study with modest sample size, limiting generalizability. Second, analysis focused on relatively minor to moderate surgical procedures; findings may not apply to major surgery where tissue trauma is inevitable. Third, specific inflammatory mediators beyond CRP and IL-6 (TNF- $\alpha$ , complement activation markers) were not measured. Fourth, our study did not include regional anaesthesia (spinal, epidural), which may demonstrate different profiles than both LA and GA. Fifth, confounding variables such as perioperative fluid administration, transfusion requirements, and antimicrobial prophylaxis timing were not analyzed in multivariate model. Sixth, tissue handling grade was subjective assessment by surgeons despite blinding.

### Conclusion

This prospective comparative study demonstrates that local anaesthesia is associated with significantly

lower perioperative blood pathology marker elevation and reduced postoperative morbidity compared to general anaesthesia.

From clinical perspective, local anaesthesia should be preferred for surgical procedures amenable to local infiltration or field block, as it provides superior hemodynamic stability, attenuated inflammatory response, reduced tissue trauma, and lower postoperative morbidity. When general anaesthesia is necessary, implementation of trauma-minimization strategies including optimized anesthetic agents, normothermia maintenance, minimized volatile anesthetic exposure, and cell salvage techniques may help reduce perioperative inflammatory burden.

Future research should employ larger multicenter designs, advanced coagulation monitoring, and longer-term follow-up to further establish blood pathology markers as predictors of postoperative complications and to identify optimal perioperative management strategies for mitigating surgical stress response.

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